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ABSTRACT

Effects of varying latencies upon articulatory productions in the stimulus-response paradigm were studied. Zero latency was compared to latency equal to stimuli and to latency with silent rehearsal of muscular movements. Thirty children with misarticulated /r/ from kindergarten, first, and second grades participated as subjects. Stimulus /ra/ was recorded on tape to provide 30 stimulations per subject. Tape 1 contained stimuli with no latency; tape 2 had stimuli with latency; and tape 3 contained stimuli with latency and conditioning for muscular practice. The first, tenth, twentieth, and thirtieth responses of each subject were judged. Only the responses following zero latency yielded significantly improved responses after 30 stimulus-response trials. It would appear desirable to continue to use the stimulus-response method with latencies adapted to the individual subject. (Author/EE)

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The Effects of Varying Latencies in the Stimulus-Response Paradigm of Speech Therapy

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Although speech clinicians have probably used some form of the stimulus-response method more widely than any other method, relatively little research has been produced to support its effectiveness. Rationale has been advocated for the use of certain frequencies of stimulations, latencies, reinforcements, and evaluations. Research, however, to support the procedures is limited. Studies in psychology have demonstrated relationships between time of presentation and response, and that latency has an effect on the recall after an interval of time. Latency as studied by psychologists in verbal learning tasks may not be relevant in speech production tasks, however, because of the lag between perception and production of sounds.

Studies in speech pathology support the relationship between latency and production of sounds. Hull's results (1948) showed that when the subject repeated a sound after the examiner without a delay, he was less accurate than when his response was delayed. Although not significantly diferent from zero, the nine-second interval in Romans and Milisen study (1954) produced the greatest number of accurate responses of the latency periods (0,3,9,27). Webb and Siegenthaler (1957) agreed with Hull that stimulation with immediate production was not effective. Latency equal in duration to a stimulus was found by Flenner (1971) to be more con-

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-ducive to improvement in imitative accuracy of Spanish phrases than zero latency for both deviant and normal-speaking children. In a doctoral study, Hulit (1972) found that the natural latency between stimulus and response for normal subjects who tried to repeat non-English consonant-like sounds decreased as the responses became more accurate.

STUDY ONE

It was the purpose of the first and more comprehensive study to investigate the latency between the stimulus and response as examined under three conditions: no latency, latency equal to length of stimulus, and latency equal to length of stimulus during which subject practices motor movements without voice.

STIMULI

The consonant /r/ was chosen for this study since it was one of the two most frequent errors among children selected for the study. The fidelity of the recorded /r/ was also found to be superior to that of the /s/ sound. The experimental stimulus was the nonsense syllable /ra/; the conditioning stimulus was /sa/. The original recordings were made into tape loops which were then played through the Magnecord to make approximately 50 reproductions of each stimulus.

Two tapes were spliced together. A /sa/ stimulus cut from the master tape, was spliced to a one-half second 1000 Hz tone, followed by a piece of blank tape equal to twice the length of the stimulus /sa/. This sequence was repeated 15 times. The zero latency /ra/ was prepared in the same way. Tape 2-- latency was prepared in the same manner as Tape 1 except for the /ra/ stimuli which were followed

by latency with mimetic muscular practice.

Instrumentation

Two Wollensak tape recorders, two headsets, a junction box which connected both headsets to the stimuli-presenting tape recorder, and a microphone connected to the response-receiving tape recorder were used. The two tape recorders were placed side by side and positioned so that the investigator could operate the controls on both machines at the same time.

Selection of Subjects

Children from the kindegartens, first, and second grades in six Columbus, Ohio, schools were screened with the first subtest of the OTAPS which samples all consonant sounds in two positions. Those children who had had no therapy and had at least three articulatory errors, one of which was the consonant /r/ in the initial position, were selected provided the intelligence fell with normal range and the children were free from hearing loss of physical disabilities. Ninety children were finally selected who met the criteria.

Design of the study

Three conditions were established: stimulation with no latency between stimulus and response; latency equal to twice the length of stimuli; latency equal to twice length of stimulus with conditioning to practice silently the muscular movements necessary for the production of the sound during the latency. No reinforcement was used for any condition. For each of the three conditions, 30 children were randomly assigned, ten from each grade. Each of the grade groups was subdivided into six subgroups of five each.

Testing Procedures

Each subject was seated approximately 18 inches from the microphone. The subject was conditioned to the testing situation with /sa/ according to the latency condition under which he was tested. An audible signal recorded on the tape signalled the child when to respond. Each subject was given ten trials with /sa/ as pretest conditioning for the experimental stimuli. Both the practice and testing were done through earphones worn by both the subject and the investigator. Each stimulation was interrupted after the tone signal was presented to allow the child to prepare for the next stimulus. After the first 15 responses, the tape was reversed. The child, thereby, was able to rest a brief period before the second set of 15 responses were repeated making a total of 30 responses for each child. During the testing, the investigator turned his back to the child so no reinforcement or evaluation would be presented at any time.

Preparation of judging tapes

In order to sample the responses of each subject, the first, tenth, twentieth, and thirtieth responses of each subject were dubbed onto judging tapes. Three tapes were made, one for each condition. When the judging tapes were completed, 120 responses were randomized according to trials on each of three tapes, each tape representing a condition. Each response was introduced by an identifying number recorded by the investigator. There was a five-second pause between each response to allow time for ratings by judges. Tape 1 contained the responses of children in group with

no latency; Tape 2 had responses of those with latency; and Tape 3 had those with latency and muscular practice.

Judging Procedures

The subject's responses were rated on a five-point descriptive scale:

1. correct production of /r/ in /ra/
2. phonemic distortion
3. nonphonemic distortion
4. substitution of another phoneme
5. omission of /r/

The judges were ten graduate students in speech pathology at The Ohio State University. Groups of judges, 3 or 4 of the ten, rotated order of tapes in listening. The judges listened with headsets and were separated from one another by empty seats. The reliability of judges was .97 as obtained through analysis of variance and Spearman-Brown formula.

Statistical Treatment

The means of the judges' ratings for each child for Trials 1, 10, 20, and 30 were tabulated for statistical treatment by analysis of variance, mean differences, t tests for independent means, and critical differences.

Results and Discussion

Zero latency yielded significantly improved responses after 30 stimulus-response trials (Table 1); specifically, it was found that Trials 10, 20, and 30 resulted in significantly better productions from 10 to 20 and from 20 to 30 although these differences were not statistically significant. (Table 1 about here)

When scores on Trial 30 were compared, no significant differences among the three conditions were shown. When change scores among pairs were com pared, however, the zero latency condition produced significantly more improvement from Trial 1 to Trial 20 and from Trial 1 to Trial 30 than the latency condition which act-

-ually yielded steady regression through all trials. Latency and muscular practice, however, did result in progressive improvement although not significant. Means for the three conditions and trials appear in Table 2. No differences were found among grades for any condition; sex differences did occur but cannot be readily interpreted. (Table 2 about here)

According to the raw data, some individuals responded satisfactorily under a given condition of latency; whereas, others did not progress or may even have regressed. It seems reasonable to conclude at this time, therefore, that whether or not a therapist should use latency equal to length of stimulus or silent muscular practice during latency should depend on what works best for the individual. Perhaps the broadest conclusion one may make on the basis of evidence presented is that the stimulus-response method without reinforcement appears to yield improvement. Even though the improvement was statistically significant for the zero latency condition only, 46 of 90 subjects made some improvement with 30 stimulus-response trials. Twenty-seven, however, regressed. Significant differences among groups might have occurred if reinforcement had been added following each improved or correct response, although studies by Romans and Milisen (1954) and Flenner (1971) did not include reinforcement and the subjects showed improvement.

STUDY II

The second study which was a continuation and replication of that reported in the first study resulted in no significant differences. The first three conditions without reinforcement were

the same as in the first study except for the prolongation of the /ra/ stimulus. The same three conditons were repeated with the inclusion of some social reinforcement. Differences between the first and tenth trial were studied for responses immediately following stimulus, responses following latency equal to length of stimuli, responses following muscular practice during latency, and each of these followed by social reinforcement.

Subjects

Ten children between the ages of 5.5 and 8.1 years, chosen for this study, had a consistent error for the consonantal /r/ as determined on five test words with different phonetic environments: rabbit, red, run, river, road. All subjects had normal hearing and normal intelligence.

Stimuli

A prolonged /ra/ syllable was duplicated 60 times to provide a consistent stimulus. Each condition was prepared by splicing a a duplicate of the stimulus with the selected latency, adding a pure tone signal, and allowing a length of blank tape for stopping and starting of the recorders. Each sample was then reproduced ten times to provide the stimuli to be used to train each subject. A length of leader tape was placed between each condition for ease of identification.

Two tapes were prepared in the manner described above. Tape 1 consisted of /ra/, zero latency, pure tone signal, and space for response. The pattern was repeated ten times. Tape 2 was prepared in the same manner except the latency was the length of the syllable. These two tapes were used for each of the six conditions of the

study. No reinforcement was used for the first three conditions: no latency, latency, practice. Scaled evaluations of the subject's response to each stimulus were used as reinforcements: about same, not bad, much better, good, very good.

Procedures

The six conditions were presented to the subjects in random order. The tapes were played on a Wollensak. The first and tenth responses were recorded on an iterval recorder.

The instructions to the subject before conditions with latency, no latency were: "You will hear a silly word. When you hear the beep, say the silly word." The instructions for conditons concerned with mimetic practice "you will hear a silly word. Practice the silly word silently. When you hear the beep say the silly word".

Judging

The first and tenth responses were paired in random order. These 60 pairs were then spliced together in random order and presented to a panel of five judges, who were asked to select one of the two responses which they perceived as better. The judges were all graduate students and trained in perception of misarticulations. The reliability coefficient,(Winer, 1962) although significant at .01 level, was not high.

One factor which may have accounted for the lack of significance in the second study was the basis upon which the subjects were chosen. Each subject who participated in the study was consistent in producing the sound inaccurately in five words. It is possible that those children who are consistent in production of errors need more than the repetition of an acoustic stimulus to learn a sound.

DISCUSSION

According to the results of the research reported in two studies, one with 90 children and the other with 10 children, no definitive statements concerning the value of latency in the stimulus-response paradigm may be made. The first study which was the more comprehensive supported the use of zero latency between the stimulus and response as preferable to a latency equal to the length of the stimulus. If this result can be accepted, practice of no latency between stimulus and response may be supported. Using the same subjects for all conditions in the second study did not result in significant differences among the three latencies. Neither did the addition of reinforcement contribute to improved responses. This result could have been affected by the consistency of the error sound and an inadequate number of stimulations for the well established error.

These two studies on latency are in disagreement with that of Flenner (1971) who found that a group of 12 seven and eight-year-old children with misarticulations who repeated Spanish phrases improved significantly from Trial 1 to Trial 5 with a latency period equal to the length of the stimulus; whereas, the zero latency yielded no significant improvement. The Spanish phrases, however, were five syllables long as compared to the one syllable used in the present studies. No significant differences occurred, however, between the conditions when change scores were compared; the same result also held for the normal speakers.

A visual signal may have been more desirable, since it is possible that the pure tone used as signal for the response may have

interfered with the auditory image of the stimulus. The latency period should probably begin at the onset of the stimulus as in learning studies. Information processing during the act of listening is an important part of the total acquisition process. Since it is recognized that articulation is a motor process, and a lag often occurs between perception and production among children with misarticulations, the first step in studying latency may be in relation to the perception of the stimuli. Short term memory or decay of the auditory image may be involved accounting for the need for the relatively short or no latency between stimulus and response.

If further research indicates that no latency is superior to latency, it may be that delay of response contributed to forgetting or decay of the auditory image. Because the stimulus-response paradigm is so popular in speech therapy, further research is indicated to support the various steps and procedures used. Such variables as frequency of stimulation preceding each response, normal length of latency, length of stimulus, stimulability, and consistency of error need to be studied in relation to the strength or accuracy of the responses.

The need for further study of the stimulus-response-reinforcement paradigm as used in speech pathology is indicated by the present research. Until further research, however, confirms or rejects the findings of these studies, it would appear desirable to continue to use the stimulus-response method with latencies adapted to the individual.

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TABLE II. Means for zero latency, latency, and latency with muscular practice for Trials 1, 10, 20, and 30.

Trials	Conditions		
	No Latency	Latency	Latency and Muscular Practice
1	2.35	2.45	2.41
10	2.17	2.47	2.27
20	2.05	2.57	2.34
30	2.03	2.58	2.22

Scale:

1 - correct production
2 - phonemic distortion
3 - unphonemic distortion
4 - substitution
5 - omission

TABLE I. CRITICAL DIFFERENCES FOR COMPARISON OF TRIALS FOR CONDITION ONE (NO LATENCY)

Trials	Means[1]	Trials 1	10	20	30
1	2.35	-	.18[a]	.30[b]	.32[b]
10	2.17	-	-	.12	.14
20	2.05	-	-	-	.02
30	2.03	-	--	-	-

[a] Need .1774 for significance at the .05 level

[b] Need .2296 for significance at the .01 level

(1) Scale

1 - correct production
2 - phonemic distortion
3 - unphonemic distortion
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Abstract: The Effects of Varying Latencies in the Stimulus-Response Paradigm of Speech Therapy

Effects of varying latencies upon articulatory productions in the stimulus-response paradigm were studied. Zero latency was compared to latency equal to stimuli and to latency with silent rehearsal of muscular movements. Thirty children with misarticulated /r/ from kindergarten, first, and second grades participated as subjects in each of three latency conditions. Stimulus /ra/ was recorded on tape to provide 30 stimulations per subject. Tape I contained stimuli with no latency; Tape II had stimuli with latency; and Tape III contained stimuli with latency and conditioning for muscular practice. The first, tenth, twentieth, and thirtieth responses of each subject were judged. Only the responses following zero latency yielded significantly improved responses after 30 stimulus-response trials. No significant differences were found among conditions after 30 trials. When change scores between Trail 1 and Trial 30 were compared, the zero latency condition was significantly bettter than the latency condition. When individuals were studied, however, some improved under a given condition whereas others did not or may even have regressed. It would appear desirable to continue to use the stimulus-response method with latencies adapted to the individual subject.